while frames of a predetermined class are forwarded over enhanced forwarding paths if these alternate paths are available.

In the STAR Bridge Protocol, all three bridge processes specified for the IEEE 802.1D Bridge Protocol and set forth above are still relevant. However, three new processes are further specified, namely *path finding process*, *STAR learning process*, and *STAR forwarding process*. The path finding process allows a STAR bridge to find and estimate the distance of a path from itself to another STAR bridge. The STAR forwarding process and the STAR learning process are modified versions of the forwarding process and the learning process specified in the IEEE 802.1D standard respectively. All STAR bridges can execute both the standard and the new processes, employing hardware already resident in non-STAR bridges.

In the IEEE 802.1D standard, a *rooted spanning tree (RST)* is built before the forwarding and learning processes start. The STAR Bridge Protocol builds, in a similar manner, an RST before the execution of the path finding process, the STAR forwarding process and the STAR learning process. The RST is found by old and STAR bridges alike. A STAR bridge can identify whether a neighbor bridge is an old bridge or a STAR bridge while the RST is being computed. This can be done by using reserved bits in the bridge messages, or having the neighbor send an extra bridge frame. We refer to a non-tree link that directly connects a pair of bridges that are on different branches of the IEEE 802.1D spanning tree as a *crosslink*. The STAR Bridge Protocol identifies appropriate crosslinks to be used for constructing enhanced forwarding paths.

The path finding process follows after the spanning tree algorithm is executed. During this interim period until the path finding process ends, STAR bridges and old bridges execute the standard forwarding process and the standard learning process while data frames are forwarded on tree paths. When the path finding process ends, each STAR bridge begins to execute the STAR learning process and the STAR forwarding process instead of the standard ones executed by old bridges when it receives a data frame.

One of the significant features and advantages of the present invention resides in the interoperability, i.e., the backwards compatibility of the STAR bridges with old bridges meeting the present IEEE standards described above. This enables advantageous use of STAR bridges in a system wherein standard bridges may be replaced in a gradual, orderly fashion thereby providing a system with the advantages derived from STAR bridges and thereby avoiding the need for a large capital expense which will result from full replacement of all standard bridges by STAR bridges at one time.

Even a system incorporating all STAR bridges provides the capability of providing enhanced paths not heretofore capable of being obtained in a system employing standard bridges.

BRIEF DESCRIPTION OF THE FIGURES

The present invention will hereinafter be described in conjunction with the appended drawing figures, wherein like numerals denote like elements, and:

FIG. 1 is a diagram showing bridge protocol architecture for connecting two LANs via remote or local bridging;

FIG. 2 is a bridge state transition diagram for the STAR Bridge Protocol;

FIG. 3 is a port state transition diagram showing both the standard states and the additional states according to the STAR Bridge Protocol;

FIG. 4 shows an encapsulated data frame;

FIG. 5 is a STAR bridge operation flow chart;

FIG. 6 is a flow chart for the process BPDU_PROC;

FIG. 7 is a flow chart showing the procedure for processing DVCN_SBPDU frames;

FIG. 8 is a flow chart for the process Data_Frame_Proc;

FIG. 9 is a flow chart for process SLA_SBPDU_Proc.;

FIG. 10 is a bridged LAN graph useful in explaining the non-tree links between STAR bridges of the present invention;

FIG. 11 is an example of a STAR bridge graph;

FIG. 12 is a flow chart of the process DVC_SBPDU_Proc.;

FIG. 13 is a graph useful in explaining the computation of a tree path;

FIG. 14 is a flow chart of the process DVMy Info_Proc.;

FIG. 15 is a flow chart of the process DVOur Info_Proc.;

FIG. 16 is a flow chart of the process DV Inform_Proc.;

FIG. 17 is a flow chart of the process DV Record_Proc.;

FIG. 18 is a flow chart of the process DF_STAR_Learning_Proc.;

FIG. 19 is a flow chart of the process FD_Search_Proc.;

FIG. 20 is a flow chart of the process ESL_Search_Proc.;

FIG. 21 is a flow chart of the process Std_Data_Frame_Proc.;

FIG. 22 is a flow chart of the process DF_STAR_Forwarding_Proc.;

FIGs. 23a-23c are diagrams useful in explaining the possible paths between end stations, showing tree paths and enhanced forwarding paths;

FIGs. 24a-24d are diagrams useful in explaining examples of forwarding paths when at least one of the agent bridges of the end stations is not defined;

FIGs. 25a-25c are diagrams useful in explaining examples of selection of tree paths when the agent bridges of both end stations are defined;

FIG. 26 is a diagram useful in explaining the selection of a tree path when the agent bridges of the end stations are defined and are different; and

FIG. 27 is a diagram useful in explaining the selection of a tree path when the agent bridges of the end stations are defined, are not the same and one is the ancestor of the other.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

I.   SPANNING TREE ALTERNATE ROUTING (STAR) BRIDGE PROTOCOL

I.A.   Bridge States

The ensuing detailed description provides preferred exemplary embodiments only, and is not intended to limit the scope, applicability, or configuration of the invention. Rather, the ensuing detailed description of the preferred exemplary embodiments will provide those skilled in the art an enabling description for implementing a preferred exemplary embodiment of the invention. It being understood that various changes may be made in the function and arrangement of elements without departing from the spirit and scope of the invention as set forth in the appended claims.

FIG. 2 shows a bridge state transition diagram for the STAR Bridge Protocol. There are five states: Tree Learning, Tree Learned, Distant Neighbors Found, Direct Neighbors Found, and Enhanced states. The first two states capture the behavior of an old bridge in accordance with the IEEE 802.1D standard,